

3.4 Exploratory Analysis of Data

The raw data were analyzed in terms of the effect of engine activity on fuel use and emissions. A rank correlation analysis was performed to identify which engine variable is highly correlated with variations in fuel use and emission rates. Table 13 is an exploratory analysis of data from a selected front-end loader. Based on an example of this as well as other vehicles, manifold absolute pressure (MAP) has been consistently identified as the engine variable most highly correlated with variations in fuel use and emission rates.

The data were also analyzed in terms of the fuel use and average emission rate for activity modes. An activity mode can include idling, movement of the equipment for repositioning purposes, use of a blade or bucket, etc. These modes can vary depending on the type of vehicle. In Figure 9, an example is shown based on a front-end loader to represent time-series fuel use and emissions in terms of different activity modes. The lowest MAP, fuel use and NO emission rates are associated with the idling mode. The peak in MAP corresponds to the peak in fuel use and NO emission rates during moving and bucket modes. Activity modes are useful to explain the variations of fuel use and emissions among different work activities.

3.5 Modal Analysis

The quality assured data were analyzed in terms of the fuel use and average emission rate for engine-based and task-oriented modes. Manifold absolute pressure (MAP) has been consistently identified as the most highly correlated engine variable associated with variations in fuel use and emission rates. Therefore, engine-based modal emission rates were estimated based on ranges of normalized MAP. Based on Backhoe 1 data, the comparison of engine-based modal average emission rates for B20 versus PD is shown in Figure 10 for a time basis and Figure 11 for a fuel consumed basis, respectively. The engine-based and time-based modal average fuel use and emission rates of CO₂, NO_x, HC, CO, and PM for all 15 NCDOT construction vehicles fueled with both B20 and PD are shown in Appendix F.